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Optimal Control Applications in Space Situational Awareness

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There are currently more than 19,000 trackable objects in Earth orbit, 1,300 of which are active. With so many objects populating the space object catalog and new objects being added at an ever increasing rate, ensuring continued access to space is quickly becoming a cornerstone of national security policies. Space Situational Awareness (SSA) supports space operations, space flight safety, implementing international treaties and agreements, protecting of space capabilities, and protecting of national interests. With respect to objects in orbit, this entails determining their location, orientation, size, shape, status, purpose, current tasking, and future tasking. For active spacecraft capable of propulsion, the problem of determining these characteristics becomes significantly more difficult. Optimal control techniques can be applied to object correlation, maneuver detection, maneuver/spacecraft characterization, fuel usage estimation, operator priority inference, intercept capability characterization, and fuel-constrained range set determination. A detailed mapping between optimal control applications and SSA object characterization support is reviewed and related literature visited. Each SSA application will be addressed starting from first-principles using optimal control techniques. For each application, several examples of potential utility are given and discussed.